

[001] **TITLE OF THE INVENTION:**

[002] Method of cryogenic treatment of tungsten carbide containing cobalt

[003] **FIELD OF THE INVENTION**

[004] The present invention relates to a method of cryogenic treatment of tungsten carbide containing cobalt

[005] **BACKGROUND OF THE INVENTION**

[006] In order to increase the wear resistance of components made from tungsten carbide containing cobalt, the tungsten carbide is often subjected to some form of sintering treatment. However, cryogenic treatment has been found to have a detrimental effect on the properties of such tungsten carbide, such as impact strength, and is generally avoided.

[007] **SUMMARY OF THE INVENTION**

[008] The present invention relates to a method of cryogenic treatment of tungsten carbide containing cobalt that has been determined to provide beneficial effects.

[009] According to the present invention there is provided a method of cryogenic treatment of tungsten carbide containing cobalt. A first step involves pre-treating tungsten carbide with microwave sintering, thereby changing the properties of the tungsten carbide. A second step involves lowering the temperature of the microwave sintered tungsten carbide gradually to cryogenic levels. A third step involves raising the temperature of the microwave sintered tungsten carbide gradually back to ambient temperatures.

[010] The cryogenic treatment of the microwave sintered tungsten carbide, as described above, has been determined to provide significant beneficial effects, as will hereinafter

be further described. Pre-treating the tungsten carbide with microwave sintering. Microwave sintering appears to change the properties of the tungsten carbide in a way which enables beneficial effects to be obtained through subsequent cryogenic treatment.

[011] **BRIEF DESCRIPTION OF THE DRAWINGS**

[012] These and other features of the invention will become more apparent from the following description in which reference is made to the appended drawings, the drawings are for the purpose of illustration only and are not intended to in any way limit the scope of the invention to the particular embodiment or embodiments shown, wherein:

[013] **THE FIGURE** is a flow diagram illustrating a preferred method of cryogenic treatment of tungsten carbide.

[014] **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

[015] The preferred method of cryogenic treatment of tungsten carbide containing cobalt will now be described with reference to **THE FIGURE**.

[016] A first step involves pre-treating tungsten carbide containing cobalt with microwave sintering. Microwaves generated from microwave generator 10 are channelled through microwave waveguide 12 into microwave applicator 14 and thereby affecting tungsten carbide 16 within. It is believed that microwave sintering changes such properties of the tungsten carbide to make it compatible with subsequent cryogenic treatment. It is believed that microwave sintering rounds the edges of the grains. Smaller grain size can be used.

[017] A second step involves lowering the temperature of the microwave sintered tungsten carbide 18 gradually over a

period of hours to cryogenic levels in cryogenic unit 20. The temperature is lowered between 2-4 degrees fahrenheit per minute to reduce thermal shock.

[018] The temperature reached at cryogenic levels will depend upon whether helium or nitrogen is used in the cryogenic process. Nitrogen is the least expensive of the two gases and provides a cryogenic temperature of minus 320 fahrenheit. For best results, the temperature should be held at cryogenic levels for a period of time. This "dwell time" is intended to ensure that the cold reaches to the core of the material. A dwell time of approximately one hour for every inch of thickness of the material is recommended.

[019] A third step involves raising the temperature of the microwave sintered tungsten carbide 18 gradually over a period of hours back to ambient temperatures in cryogenic unit 20. The same guidelines of 2 to 4 degrees per minute is recommended.

[020] Beneficial results obtained through treatment:

[021] The results obtained through the above described process vary depending upon the cobalt content of the tungsten carbide. The cobalt content generally varies between 6% and 16%. As a general rule the higher the cobalt content, the more beneficial the results obtained.

[022] When compared to tungsten carbide that had been treated with microwave sintering alone, the above described combination of microwave sintering and cryogenic treatment:

[023] - increased impact resistance by between 20% and 30%
 - increased corrosion resistance by between 200% and

300%

- increased wear rate by between 200% and 300%
- increased toughness and ductility
- reduced residual stresses

[024] These results are both dramatic and unexpected. It is believed that with the finer grain size and rounded edges evidenced after microwave sintering enables the cryogenic treatment to bring the tungsten carbide down to more theoretical densities, further reducing porosities, producing finer grain structures and stronger more uniform molecular bonding of the tungsten carbide/cobalt matrix with reduced stresses.

[025] In this patent document, the word "comprising" is used in its non-limiting sense to mean that items following the word are included, but items not specifically mentioned are not excluded. A reference to an element by the indefinite article "a" does not exclude the possibility that more than one of the element is present, unless the context clearly requires that there be one and only one of the elements.

[026] It will be apparent to one skilled in the art that modifications may be made to the illustrated embodiment without departing from the spirit and scope of the invention as hereinafter defined in the Claims.